



TROPICAL CYCLONES AND CLIMATE CHANGE: FACTSHEET



Background

Cyclone Debbie, a devastating category 4 storm, ripped through north Queensland on 28 March 2017 with wind gusts exceeding 260 km/h. Around 60,000 homes were without power in the Bowen, Mackay and Whitsunday regions. Widespread damage has been reported, including downed trees, flooded houses and properties, collapsed buildings and flattened cane crops. Now downgraded to tropical low, the system is tracking southwards through Queensland. This storm has prompted many people to ask the Climate Council about the influence of climate change on cyclones.

The Influence of Climate Change on Tropical Cyclones

Climate change is likely to affect tropical cyclone behaviour in two ways. First, the formation of tropical cyclones most readily occurs when there are very warm conditions at the ocean surface and when the vertical temperature gradient through the atmosphere is strong. As the climate continues to warm, the difference between the temperature near the surface of the Earth and the temperature higher up in the atmosphere, is likely to decrease as the atmosphere continues to warm. As this vertical gradient weakens, it is likely that fewer tropical cyclones will form (DeMaria et al. 2001; IPCC 2012).

Second, the increasing temperature of the surface ocean affects the intensity of cyclones (along with changes in upper atmosphere conditions), both in terms of maximum wind speeds and in the intensity of rainfall that occurs in association with the cyclone. This is because the storms draw energy from the surface waters of the ocean, and as more heat (energy) is stored in these upper waters, the cyclones have a larger source of energy on which to draw (Emanuel 2000; Wing et al. 2007). In summary, it is likely that fewer tropical cyclones will form as the climate warms, but a higher fraction of those that do will be intense, more damaging cyclones.

Consistent with this basic physical understanding, a statistically significant increase in intense cyclone activity has been observed in the North Atlantic region since the 1970s (Kossin et al. 2007; IPCC 2013). However, for most regions around the world, trends in tropical cyclone frequency and intensity are difficult to discern because of the lack of long-term, consistent observational data. This is the case in Australia, where for the 1981 to 2007 period, no significant trends in the number of cyclones or their intensity were found (Kuleshov et al. 2010), although a comparison between tropical cyclone numbers in 1981-82 to 2012-13 shows a decreasing trend (Dowdy 2014).

Coastal flooding: the most direct link to climate change

The most direct influence of climate change on the impacts of tropical cyclones is via **coastal flooding**. Typically the damage from tropical cyclones comes from:

1. Excessively high winds that directly damage built infrastructure and the natural environment; and
2. Coastal flooding caused by a storm surge, and the heavy rainfall that often accompanies the storm.

What is a storm surge?

A storm surge is a **rise above normal sea level resulting from strong onshore winds and/or reduced atmospheric pressure**. Storm surges, which accompany tropical cyclones, can cause extensive flooding of coastal areas. The area of sea water flooding may extend along the coast for hundreds of kilometres, with water pushing several kilometres inland if the land is low-lying. The worst impacts of a storm surge occur when it coincides with a particularly high tide (Figure 1).

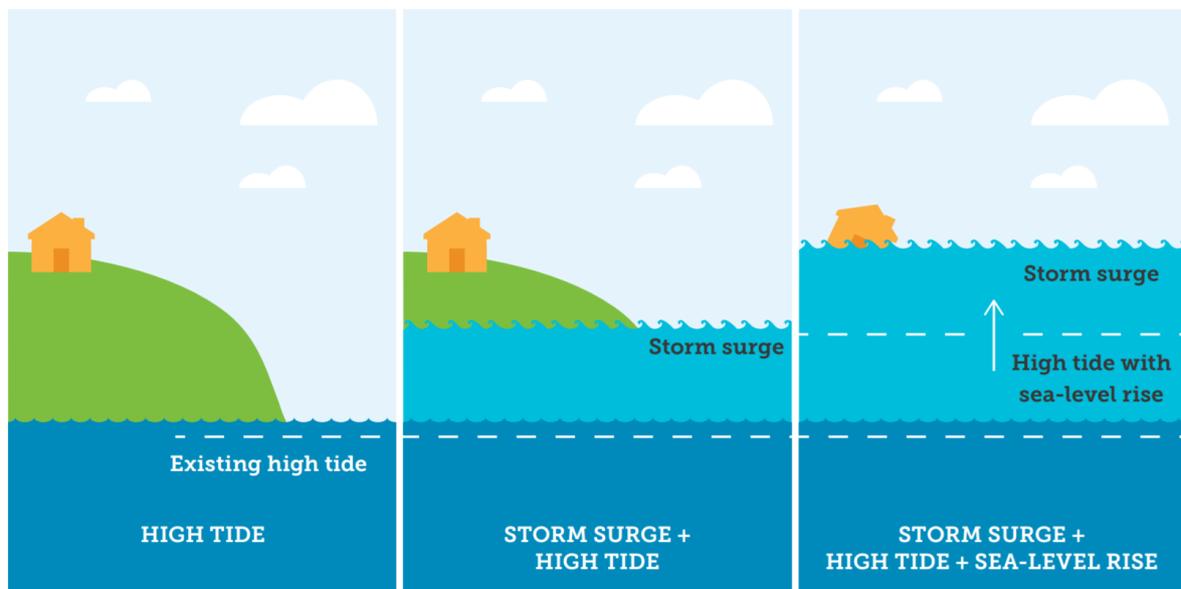


Figure 1: Climate change increases the base sea-level and thus exacerbates the effects of a storm surge on coastal flooding (Climate Commission 2013).

How are storm surges affected by sea-level rise?

The rise of sea levels globally because of climate change – due to warming oceans and melting ice sheets – means that **storm surges are now riding on higher sea levels than they were earlier**, increasing the extent and severity of flooding damage from cyclones and other weather systems than can drive storm surges.

Counting the cost

Because of climate change, [storms are now occurring in a more energetic, moisture-laden atmosphere](#) – a recipe for more destructive storms. Further, destructive storms have huge social costs.

Health Impacts

Storms such as tropical cyclones can cause damage to property, infrastructure and claim human lives. While storms can cause immense physical damage, they can also cause mental distress. Studies have shown that in the aftermath of severe storms, survivors demonstrated a 25% increase in the onset of depression after the storm event. Emotional stress can undermine the resilience of individuals and communities, placing further physical, emotional and financial burdens onto recovery efforts (Martin 2015).

Environmental Impacts: Coral Reefs

The Great Barrier Reef is already under threat from climate change, devastated by the [worst ever mass bleaching event last year](#) and with no reprieve this year as a new bleaching event unfolds.

What are the risks and benefits of tropical cyclones for coral reefs? Winds, cloud and rain associated with tropical cyclones can cool sea surface temperatures. For example, the southern section of the Great Barrier Reef was spared from mass bleaching last year because of late summer cooling of ocean temperatures from ex-Tropical Cyclones Winston and Tatiana (GBRMPA 2016). Whereas, on the downside, climate change could result in [more intense tropical cyclones hitting the Australian coast](#), which will in turn increase the risk of physical damage to reefs.

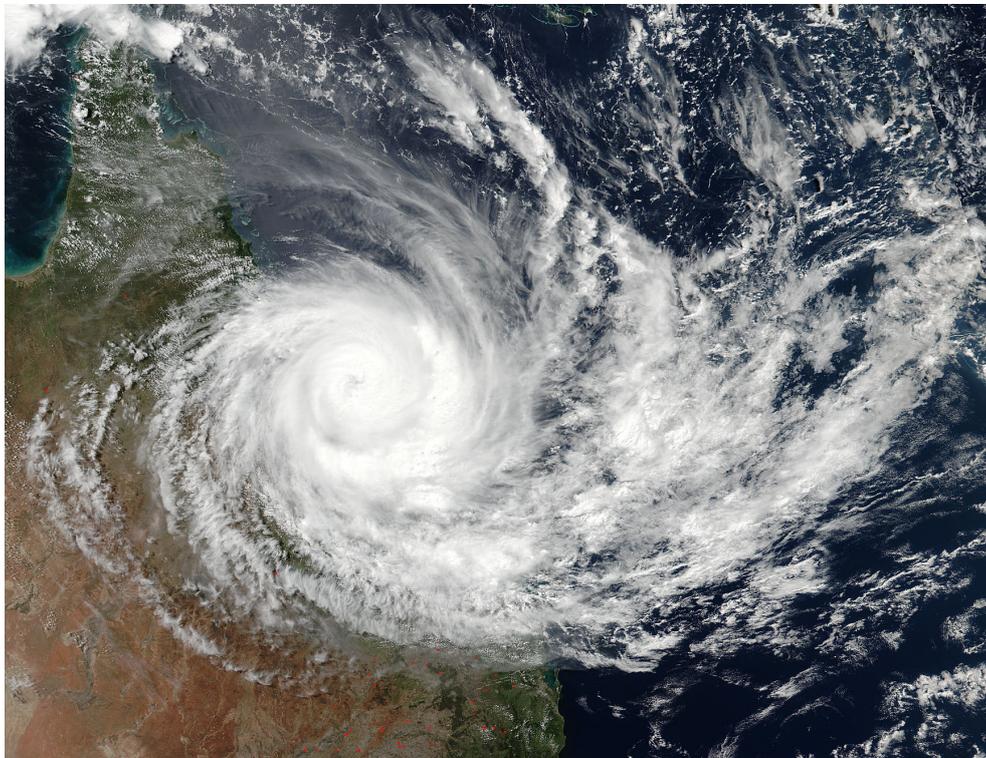


Figure 2: Tropical Cyclone Debbie making landfall over the north Queensland coast. Climate change could result in more intense cyclones which can cause physical damage to reefs.

It's too early to assess if Tropical Cyclone Debbie will halt progress of the mass bleaching currently occurring on the Great Barrier Reef. It's also too early to say what physical damage the Tropical Cyclone will inflict on the reef. Only six years ago, Tropical Cyclone Yasi passed over large areas of the reef. Coral damage was reported across an area of approximately 89,000 km² of the Great Barrier Reef Marine Park. In total 15% of the park sustained some damage and 6% was severely damaged (GBRMPA 2011). The ecological impact of this severe tropical cyclone is likely to be evident for several decades (GBRMPA 2011).

Economic Impacts

The damages in Australia from major flooding, tropical cyclones and severe storms for the 1967-1999 period were estimated to be \$28.6 billion, based on 2008 residential pricing (DCC 2009). Australia has experienced a stormy last five years, with some of the most damaging storm events in recent times occurring within this period. For example, Cyclone Yasi caused huge economic impacts. It was one of the most powerful cyclones to have affected Queensland since records began, and was one of Australia's costliest natural disasters. Cyclone Yasi first hit the North Queensland coast on 2 February 2011, creating widespread damage and contributing to flooding across Queensland. The cyclone brought extreme winds of up to 285 km/h, heavy rain of up to 200-300 mm in 24 hours and storm surges, including a 5 m tidal surge at Cardwell (QRA and World Bank 2011). The costs to the agricultural and tourism industries were estimated at \$1.6 billion and \$600 million respectively (QRA and World Bank 2011).

Cyclones in Australia: General projections for the future

An increase is likely in the proportion of the most intense tropical cyclones, those with stronger winds and heavier rainfall such as Yasi, while the total number of tropical cyclones will likely decrease. A greater proportion of Tropical Cyclones may reach further south along Australia's east and west coastlines (CSIRO and BoM 2015).

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